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EFFECTIVE USE OF COMPUTER-BASED INSTRUCTION AND ASSESSMENT

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Advancing technology, increased emphasis on computer curricula, tech-savvy students, and shrinking budgets indicate that it is time to address the pedagogical issues of the introductory computing course. This study investigates the feasibility of using a hybrid instructional model of computer-based instruction with minimal classroom interaction when teaching an introductory computing course at a college or university. ANOVA reveals that computer-based instruction with minimal classroom interaction is as effective as a traditional model of lecture and hands-on instruction. Computer-based instruction provides a means to enrich students' learning experiences, maximize faculty productivity, and effectively manage scarce resources.

INTRODUCTION

General literature and popular media suggest that high school graduates arrive on college campuses with well-developed skill sets, the latest wireless devices, and expectations of a "wired" campus. Rapid technological advances, greater realities of global competition, increased quality and performance expectations of customers, and the dependence of business on information systems creates greater demands in the workplace for computer literate employees.

Colleges and universities are keenly aware of a knowledge revolution so extensive that traditional curricula can no longer provide students with enough fact-based learning to survive in a digital workplace. To remain institutionally as well as educationally viable, higher education introductory computer courses merit continual review to ensure that relevant learning experiences and marketable skills are taught.

Introductory Computing Courses

In the early 1990s, educators and administrators claimed that the introductory computer literacy course in universities would no longer exist by 2000 due to increased saturation of the personal computer in our society. Assessments of computer knowledge at the university level indicate that students have higher levels of computing skills than their predecessors; however, when assessed for the required skills to pass introductory computing courses, they are behind. Because of a wide variety of computing backgrounds and competency levels, the introductory computing course on university campuses is still necessary (Cooley & Zhang, 1998; Edmiston & McClelland, 2001).

In a typical section of the course, the skills of students range from hardly any computing experience to advanced technical skills, with the majority of students falling between these extremes. Many students believe the course is unnecessary and a waste of time because of their "experience" with computers and this belief impacts their motivation to succeed. For highly computer literate students, the course proceeds so slowly that it becomes excruciatingly boring; yet, the course proceeds too fast for students with lower skill levels and they are frustrated (Cooley & Zhang, 1998, Robinson & Thoms, 2001; Sax, Ceja, & Teranishi, 2001).

Being unable to assume prior knowledge of the most basic information technology skills, college instructors must design a quality "one size fits all" course at the university level that may not address the learning needs of today's student. Methods of teaching the introductory computing course have evolved from a lecture-only data processing course of the 1970s to a lecture and hands-on model of the 1980s taught in computer labs.

With greater numbers of students enrolling in introductory courses, additional sections with more students in each section are required to keep up with enrollment; yet, budget reductions prohibit hiring faculty to teach the additional sections. Full-time faculty members are assigned to teach introductory computing courses as part of their regular contract or as an overload contract in addition to their regular teaching load. This practice results in under-utilizing available teaching resources by preventing highly qualified, senior faculty from teaching upper-division specialized courses. Heavy teaching loads also prevent students from getting individual help when they need it. Instructors have too many students and too few hours in the day to spend with individual students.

Adjunct instructors are also hired to teach sections of the introductory course. However, adjuncts may not have the same commitment to quality instruction as a full-time instructor and, most times, do not have the same responsibilities to students that full-time instructors have (i.e., regular office hours, individualized attention for students, or service and research responsibilities).

Advances in technology, increased emphasis on computer curricula, tech-savvy students, and shrinking budgets all indicate that the time has come to address the pedagogical issues of the introductory computing course.

Computer-Based Instruction and Assessment

Computer-based instruction (CBI) refers to all kinds of instructional systems where computers are used to support teaching and learning (Inoue, 2000). The most powerful feature of CBI is the capacity to individualize programmed instruction that meets specific learner needs through realistic, stimulating learning environments presented in a logical sequence. Interactivity empowers and motivates learners by allowing them to progress through the learning process at their own pace (Bennett & Cooper, 2003; Billings, 1986; Lancaster & Willis, 1994; Luna & McKenzie, 1997; Mawhinney, 1998; Pear & Novak, 1996; Rasmussen & Davidson, 1996; Skinner, 1990).

When teaching a software application course, it makes sense to assess software skills with software. Brown (2000) advises that using a skills assessment software package where tasks are completed in a simulated environment provides an effective and efficient way to get a true reading of computer proficiency. Using computer-based assessment, students and staff realize the benefits of faster marking, immediate feedback, and the appearance of fair marking procedures for assessments (Brown, Race & Bull, 1999).

The adoption of any learning system incurs costs. However, after the initial implementation of CBI, costs diminish drastically because CBI can be used as many times as needed at no additional cost. The cost to deliver CBI decreases in proportion to the number of learners using the program. With traditional classroom instruction, costs increase with an increase in the number of learners (Billings, 1986; Chang, 1986; Lancaster & Willis, 1994; Porter, 2003; Stephens, 2001).

Effectiveness of Computer-Based Instruction

Marold and Fustos (2001), recognizing the higher level of computer literacy among freshman students, proposed a hybrid model of the traditional introductory computer course to save faculty and campus resources, yet preserve the traditional classroom instruction that some students require. Their model combined a multi-section weekly general concept lecture with self-paced, Web-based tutorials and learning experiences. Marold and Fustos found that the hybrid model increased the amount of experiential learning time for students while allowing "just-in-time" delivery. Lectures given by experienced teachers to larger groups of students lent standardization to the face-to-face component of the course. The ratio of full-time to adjunct instructors improved because graduate students were assigned to lab sessions and routine course management duties. Overall, it was possible to serve more students each semester.

Facing a lack of funding for additional full-time faculty, Wallace and Clariana (2000) used a Web-based training and assessment software package to determine if students receiving CBI produced the same learning results as those receiving traditional methods. Results indicated no significant differences between the groups in the overall assessment scores. Simis and Hoong (2001) used groups of students to compare the traditional lecture and hands-on instructional model with *Skills and Assessment Manager* (SAM) training and assessment software. Online assessments indicated that there was no statistical difference between the assessment scores of the two groups.

Mackin, Johnson, and Paranto (2004) reported increased student motivation to finish the course early when a computer-based, flexibly-structured, self-paced paradigm was used in teaching the introductory course. Student feedback was positive and the faculty recognized reduced teaching/student loads. A Web-based, self-paced, competency-based computer literacy course may be more effective than the traditional "monkey-see, monkey-do" methods currently used on college campuses (Bretz & Johnson, 2000; Cooley and Zhang, 1998).

Train & Assess IT

Train & Assess IT is a Web-based product that delivers customizable training and testing software in a single program designed to create a unique learning path for every student. It is a reliable, robust, and easy to use performance-based training and assessment software system developed by Pearson Education and marketed by Prentice-Hall Publishers, Inc. to mirror the pedagogy of different textbook series available to teach Microsoft® Office, Computer Concepts, and Windows® in introductory computing courses. The assessment component of the package offers performance-based testing that shares the same user interface as the training modules to evaluate a student's knowledge about specific topics of the Microsoft Office software suite: Word, Excel, Access, and PowerPoint.

Goal of the Study

The goal of this study was to examine the viability of a hybrid, computer-based instructional model, similar to that of Marold and Fustos (2001), as an alternative to traditional instructional methods in a university introductory computing course. The study sought to answer the following question:

> Will a significant difference exist in the learning outcomes (final performance score) of students using computer-based instructional technologies and those of students receiving traditional lecture and hands-on practice instruction?

Enrollment is a factor when determining state funding in public schools. Larger schools receive more funding and it is reasonable to believe that schools with greater resources for technology and instructors are better positioned to offer expanded curricula in computer technology programs. Therefore, it was of interest to know if students from smaller public high schools in the state performed differently than the graduates from larger high schools in the introductory computing course. Thus, the study sought to answer a second question:

> Will a significant difference exist in the final learning outcomes (final performance scores) of graduates of small high schools (less than 206 students) and of graduates of large (206 or more students) regardless of the instructional model?

METHODOLOGY

Participants and Setting: Students enrolled in an introductory computing course at a medium-sized, regional university located in the Midwest participated in the study over a period of three academic semesters: Spring 2004, Fall 2004, and Spring 2005. The course is a required general education course and historically, students enrolled in the course are in the first or second semester at the university. Students choose a section of the course that fits into their semester schedule. Since most are new to the university, they are unfamiliar with the faculty and evidence no bias when choosing a section because of the instructor.

Sample and Sampling Procedures: The university offers 12 to 15 sections of the introductory course each semester and allows a maximum of 35 students in each section. In selecting the sections of the course to be included in this study, convenience sampling was used. Two sections of the course during the Spring 2004, Fall 2004, and Spring 2005 academic semesters were selected to participate in the study. The selected sections met on the same days of the week (Tuesday and Thursday) to ensure that each group received the same amount of classroom time (75 minutes). The same instructor taught all six sections to eliminate possible bias resulting from different instructors. Each semester, one section was designated a Traditional (control) group and the other section served as a CBI (treatment) group. Therefore, three Traditional (control) groups and three CBI (treatment) groups and a total of 169 students were enrolled in the six sections.

Thirteen of the original 169 participants did not complete the course. Nine students dropped the course in the first week of the semester and four remained enrolled but did not participate in the course during the semester. A Traditional (control) group of 79 participants and a CBI (treatment) group of 75 participants completed the study for a total of 154.

Data Collection

Data generated from different sources was collected from the Traditional and CBI groups at various times during each semester. The instruments used to collect data were two survey instruments, an objective assessment, four performance-based assessments, and the final performance score for the course. Objective and performance-based assessment data were used in the study to determine a final performance score for each of the participants. Survey data and the final performance scores were used in the statistical analysis and findings of the study.

Research Design

When conducting school-based research, it may not be practical or feasible to randomly assign subjects to groups because classes are formed at the beginning of the academic year or semester. This practice precludes random assignment of participants to groups (Ross & Morrison, 2004). Therefore, a nonequivalent control group design discussed by Campbell & Stanley (1963) was determined as appropriate for this study. The design consists of one treatment group and one control group as shown in figure 1.

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Figure 1: Nonequivalent Control Group Design (Campbell & Stanley, 1963: 47)

O_1 X O_1

O_2 O_2

Where: X = treatment

O_1 = treatment group

O_2 = control group

Since random assignment of the participants to groups is not present, Ross and Morrison (2004) suggest that equality of the groups be established statistically, and if significant differences exist, a statistical adjustment such as analysis of covariance can be used.

Instrumentation

Survey instruments: Participants completed a demographic survey that indicated rank, intended major, gender, age, year of high school graduation, state of graduation, name of high school, and ownership of a personal computer during the high school years. At the final meeting period of the semester, an exit survey was administered to those participants completing the study. Students were polled to determine if they had a personal computer in their home during this course and were asked to answer four satisfaction questions relative to the learning experience. These questions related to their opinions about what they liked best and least about the course and what they would change and continue to do if they were the instructor of the course.

Objective Exam: Knowledge of the conceptual component of the course was measured in week 3 of the semester using a 50-item multiple-choice instrument. Representative questions covering the content areas were selected from a test bank supplied with the course textbook, *The Exploring Series: Microsoft Office 2003* published by Prentice-Hall. The assessment tool embedded in Blackboard course management software administered the multiple-choice exam to students.

Performance-based assessments: Performance-based assessments of the participants' software skills were given after completing each of the four software application packages in the Microsoft Office 2003 suite (Word, Excel, Access and PowerPoint) using Prentice Hall *Train & Assess IT* (v. 2.3) performance-based training and assessment software system for Microsoft Office 2003. Performance-based exams occurred in weeks 5, 10, 14, and 16 of the semester.

Final performance score: A final performance score was calculated for each participant in the control and treatment groups. This score reflected the overall performance for the semester and was the calculated mean of all assessment activities during the semester.

Treatment

All participants were informed of the grading scale and other class policies with the delivery of the course syllabus on the first scheduled day of classes and they were instructed in the use of the required software for the course. Participants also activated their student e-mail accounts and determined that they were able to send and receive email via this account. Blackboard course management software allowed the instructor to post assignments and to communicate with the participants during the study. It was also used to administer the multiple-choice assessment. *Train & Assess IT* training and assessment software was demonstrated and students practiced in the classroom using the training and assessment components of the software.

The conceptual component of the course was delivered in the classroom to both the control (Traditional model) and treatment (CBI) groups in a traditional manner of lecture, demonstration and objective assessment over the first three weeks of the semester. The conceptual component included discussions of the history of the computer, hardware, software, networking, telecommunications, ethical issues, and legal considerations of computing in a digital society. A 50 item multiple-choice exam was used to assess the conceptual knowledge of each of the participants in the groups. The remainder of the semester was devoted to learning the four application software packages of the Microsoft Office suite: Word (2 weeks), Excel (5 weeks), Access (4 weeks), and PowerPoint (2 weeks).

The control groups in this study completed the course with the Traditional model of instruction (lecture and hands-on). They continued to report to the classroom each scheduled class period and learned the software application portion of the introductory course in the traditional manner - a combination of instructor lecture, demonstration, and hands-on practice. Students progressed through the course with the aid of the textbook and the guidance of the instructor. The instructor was involved in the course through lecture, demonstration of software skills, in class exercises and one-on-one assistance. Students were able to use the training modules available in the *Train IT* package for additional practice if they chose to. The software skills of the subjects in the control group were assessed after completing each application by using the *Assess IT* software package.

The treatment groups were subjected to the CBI model and were dismissed from attending scheduled class periods to progress at their own pace in completing the course by using the textbook, course management software, and assigned training modules mapped to textbook chapters. Software skills of the treatment group were also assessed using *Assess IT* software provided by the publisher.

The instructor was available during the scheduled class periods to answer questions and to assist students in the CBI groups that needed additional help. Students were encouraged, but not required, to work in the classroom during the scheduled period to remain motivated and to receive clarification or assistance in working through the material.

Research Questions

The goal of this study was to determine if a hybrid instructional model was a feasible alternative in teaching a university introductory computing course and the instruments used in collecting the data provided a rich data set for parametric analysis. The research questions and null hypotheses considered for analysis in this study were:

Question 1:	Will a significant difference exist in the final learning outcomes (final performance scores) of students using computer-based instructional technologies and those of students receiving traditional lecture instruction and hands-on practice?
H_1 :	**There is no significant difference between the final learning outcomes of students using computer-based instructional technologies and those of students receiving traditional lecture instruction and hands-on practice.**
Question 2 :	Will a significant difference exist in the final learning outcomes (final performance scores) of graduates of small high schools (less than 206 students) and of graduates of large (206 or more students) regardless of the instructional model?
H_2 :	**There is no significant difference between the final learning outcomes of graduates of small high schools (less than 206 students) and of graduates of large high schools (206 or more students) regardless of the instructional model.**

Independent Variables

ACT score served as the independent variable in the statistical procedure to determine if there were significant differences among the six groups included in the study. The Office of the Registrar provided the available *ACT* scores (121) for statistical analysis.

Instructional model (Traditional or CBI) served as the independent variable in this study to answer the first research question. In addition to the instructional model, *size of school* also functioned as an independent variable in answering the second research question. Participants who graduated from state high schools with enrollments of fewer than 206 students were designated as *small schools* and those graduates from state schools with 206 or more students were designated as *large schools*.

Dependent Variable

Final performance score functioned as the dependent variable used in the parametric analysis procedures. The mean score of the objective exam and the four performance-based assessments were averaged to determine the final performance scores of the participants.

Demographic Variables

Both surveys yielded data regarding the demographic characteristics of the sample. The descriptive variables included *age, rank, major, gender, size* and *state of high school*, and *computer ownership*.

Data Analysis

The data obtained in this study were analyzed using the *SPSS Release 11.0* statistical software package. Descriptive statistics were calculated from the data obtained from the *Demographic Survey* and the *Exit Survey*. Frequency distributions are reported for rank, intended major, gender, personal computer ownership, and characteristics of participants in the study.

When using a quasi-experimental nonequivalent control group design, Campbell and Stanley (1963: 26) and Kerlinger and Lee (2000: 472) also suggest checking the equality of groups on a pertinent variable when no pretest is given. A one-way analysis of variance (ANOVA) was determined to be the appropriate procedure to determine if there were statistically significant differences in the mean *ACT* scores of the groups at a .05 significance level. If differences were indicated by ANOVA, an analysis of covariance (ANCOVA) procedure was also planned.

General linear models of univariate ANOVA were also determined to be appropriate to indicate statistically significant differences in mean *final performance scores* at a .05 significance level. If significance of either of the ANOVAs exceeded .05, additional statistical procedures were planned *a posteriori*.

Results

Of the 154 participants in this study, 79 participants in the Traditional (control) groups experienced a lecture and hands-on instructional model to complete the course while 75 participants in the CBI groups completed the course using the computer-based instructional model.

Gender was evenly distributed between the 154 participants with exactly one-half (77) males and one-half (77) females. Within the Traditional groups, 51.9% were male and 48.1% female while 48.0% and 52.0% were male and female respectively among CBI groups.

The mean age of participants was 20.36 years, with 82.5% of the sample being younger than 21 years of age. Within the Traditional groups, the mean age of males was 20.46 years and 19.84 years for females. Mean ages of the CBI groups were 20.42 years and 20.69 years for males and females, respectively.

Nearly 84% of the participants indicated that they had graduated since 2001 and over one half graduated in 2003 or 2004 (65.6%). As expected, 69.5% (107) of the participants indicated they were freshmen (0-29 credit hours), 19.0% (30) indicated they were sophomore (30-59 credit hours) as an appropriate rank, and junior (60-80 credit hours) and senior (90 + credit hours) rank was considerably lower with 5.8% (9) and 3.2% (5) respectively. The remaining 1.9% of participants indicated "Other" as a current rank. This category can include graduate or otherwise unclassified students.

The indicated majors were assigned the code of the appropriate college in which the major is found according to the *University Catalog*. The greatest number of participants indicated a chosen major in the College of Health and Life Sciences (28.6%) while 24.7% indicated a chosen major in the College of Business and Leadership. Of the remaining participants, 22.7% and 17% of chosen majors came from the Colleges of Arts and Sciences and the College of Education and Technology, respectively. The remaining 13% were undecided when asked about a chosen major.

The university is a state institution serving western Kansas. It was not surprising that 80.5% (124) of the participants in the study graduated from public high schools. The remaining 30 participants indicated that they matriculated from out-of-state or internationally. Of the resident high school graduates, 72.7% completed their high school education in a small school (enrollment fewer than 206 students). The remaining 33.9% of resident participants graduated from large schools with enrollments of 206 or more students. When asked about computer ownership, 86.4% indicated they owned a computer while in high school and 90.3% owned a computer while completing this course in college.

Enrollment data and *ACT* scores for 33 participants were not available; however, *ACT* scores for 121 of the 154 students were available. The mean ACT score of the total number (121) of participants available was M = 21.20, SD = 3.54.

Using *ACT* as the dependent variable, a one-way ANOVA revealed F (5, 120) = 1.184, p = .322 and indicated there was no significant difference in the mean *ACT* scores for the six sections of participants included in the study as indicated in table 1.

Table 1: Analysis of Variance for ACT Score Based on Semester and Instructional Model

Descriptive Statistics

Semester X Instructional Model	Mean	Std. Deviation	n
S04 Traditional Model	23.08	4.19	12
S04 CBI Model	20.77	3.64	22
F04 Traditional Model	20.50	3.55	26
F04 CBI Model	21.95	3.90	20
S05 Traditional Model	20.86	3.14	22
S05 CBI Model	21.05	2.86	19
Total	21.20	3.54	121

ANOVA Summary

Source	Sum of Squares	df	Mean Square	F	p
Between Groups	73.47	5	14.69	1.184	.322
Within Groups	1427.77	115	12.42		
Total	55875.00	121			

$p < .05$

Based on the ANOVA result, the sections of data were pooled for further statistical analysis to answer the research questions. The Traditional group data in this study was obtained from the individual S04, F04, and S05 sections that experienced the lecture and hands-on instruction (n=79). Likewise, the CBI group data are the pooled data from the individual S04, F04, and S05 sections that experienced the computer-based instructional model (n=75).

After combining the data, ANOVA was a proper procedure to answer the first research question. Using the combined data, a univariate analysis of variance was completed to determine statistical significance at $p = .05$ and to test the null hypothesis:

> **H1:** There is no significant difference between the final learning outcomes of students using computer-based instructional technologies and those of students receiving traditional lecture instruction and hands-on practice.

Using *instructional model* and *final performance score,* respectively, as the independent and dependent variables, the test for significance F (1, 153) = .139, $p = .709$ was statistically non-significant at the .05 significance level and the null hypothesis was not rejected. The ANOVA summary table appears in table 2.

Table 2: Analysis of Variance for Final Performance Score Based on Instructional Model

Descriptive Statistics					
Instructional Model	**Mean**		**Std. Deviation**		***n***
Traditional Model	79.06		11.78		79
CBI Model	78.33		12.48		75
Total	78.71		12.09		154
ANOVA Summary					
Source	Sum of quares	*df*	Mean Square	*F*	*p*
Between Groups	20.50	1	20.50	.139	.709
Within Groups	22357.35	152	147.09		
Total	22377.85	154			

$p < .05$

Using *size of school* and *instructional model* as independent variables and *final performance score* as a dependent variable, a second ANOVA was completed to determine if significant differences at a .05 significance level existed to test the null hypothesis:

> **H2:** There is no significant difference between the final learning outcomes of graduates of smaller public high schools and those of graduates of larger public high schools in an introductory computing course regardless of the instructional model used.

The second ANOVA revealed a value of F (1,123) = .410, $p = .523$ and indicated no significant differences in the final performance scores between students of smaller and larger public high schools at a significance level of .05. Thus, the null hypothesis was not rejected. The ANOVA summary is reported in table 3.

Table 3: Analysis of Variance for Final Performance Score Based on Size of School

Descriptive Statistics					
Size of School		**Mean**	**Std. Deviation**		***n***
Class 1-2-3A (< 206 students)		79.41	11.15		82
Class 4-5-6A (206 or more students)		78.02	12.03		42
Total		78.94	11.43		124
ANOVA Summary					
Source	Sum of Squares	*df*	Mean Square	*F*	*p*
Between Groups	53.73	1	53.73	.410	.523
Within Groups	16004.88	122	131.89		
Total	788837.00	124			

$p < .05$

DISCUSSION

As expected, most of the students in the groups included in the study were in their first or second semester at the university with equal numbers of male and female participants. It was believed that most students in the introductory course were 18-20 years of age. However, participants in this study were slightly older with ages that ranged from 18 to 44 years. The mean age 20.36 years, $SD = 4.35$ suggests that (1) students are not entering college immediately after high school graduation, or (2) greater numbers of older,

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perhaps non-traditional students, are enrolled in the introductory computing course. National trends indicate that non-traditional enrollments are up on college campuses due to additional education and re-skilling required to remain competitive or to change careers in the job market.

Over 80% of the participants in the study were resident students having graduated from high schools in the state. The university is located in a rural part of the state and not near a population center and a large portion of enrollment (72.7%) in the introductory course results from graduates of smaller (less than 206 students) public high schools.

It is not surprising that nearly 87% of the students in the study groups owned a computer while in high school. Computers are deeply integrated into the K-12 environment and the pervasiveness, portability, and affordability of the devices allow parents to provide connectivity for their children in the home. An even higher percentage of students (90.3%) indicated that they owned a computer while completing this course. As more universities migrate to wireless computing environments, even more students will continue to provide their own mobile computing devices such as laptops or tablet computers until the ubiquity of computing is a reality on campuses.

The goal of this study was to determine if computer-based instruction and assessment methods are at least as effective as traditional lecture and hands-on instructional models in university introductory computing courses. ANOVA did not indicate any significant differences in the final performance scores of participants receiving traditional lecture and hands-on instruction and those participants receiving computer-based instruction thus indicating that computer-based instruction is as effective as traditional methods of instruction. CBI can be a viable, cost-effective alternative to traditional methods of instruction in introductory computing courses.

State funding for public high schools is dependent on the number of students enrolled at the 10^{th}, 11^{th}, and 12^{th} grade levels and it is reasonable to assume that students from larger schools (206 or more students) have opportunities for expanded computer curricula relative to smaller high schools in the state. A second goal of the study was to determine if the final learning outcomes of students from smaller high schools were significantly different than the final learning outcomes of those students graduating from larger high schools. A second ANOVA indicated no significant differences in final learning outcomes and it can be concluded that in this sample, students showed no differences in final learning outcomes regardless of the school size.

Limitations

The findings of this study are limited to students in the introductory computing course at a medium-size regional university in the Midwest and cannot be generalized to different groups of the population in other universities. The time periods in which the data were collected, sample size, and convenience sampling can also be considered as limiting factors for generalization.

Neither method of instruction addresses all learning styles. Students participating in this study may not have been intrinsically motivated to perform to the best of their ability; or, extrinsic motivation may have been lacking - making a "C" in the course was good enough. Differences in students' skill sets may also not be a result from the difference in motivation; the difference may lie in the institutional (high school) effects of past computing experiences. Last, students enrolled in later semesters, or years, may bring different skill sets to the classroom because of prior experiences, increased access to computers and computer classes, or advances in technology.

Implications and Considerations for Future Study

High school students will continue to arrive on college campuses with well-developed skill sets, the latest wireless devices, and expectations of a "wired" campus. The explosion of mobile computing continues to put pressure on university administrations to provide wireless connectivity for a plethora of mobile devices. Networked computing labs will give way to laptops, tablets, handheld computers and other seamlessly integrated computing devices. Students will use these devices to learn on our campuses as they prepare to enter a dynamic, technology-driven workplace that mandates lifelong learning to remain competitive in the job market.

As mobile computing and other seamlessly integrated computing devices continue to flood the marketplace, universities must continue to review and redesign introductory computing courses to address the changing standards of computer literacy. Budget cuts pressure our universities to make dollars go farther when allocating resources like faculty and facilities for teaching introductory computing courses; yet, educators must continue to focus on the future to identify emergent trends and changes in the environment that necessitate curriculum revisions.

To remain institutionally, as well as educationally viable, higher education introductory computer courses merit continual review to ensure that relevant learning experiences and marketable skills are being taught. CBI is an appropriate model of instruction now; however, pod casting, voice activated software, and integrated communication devices (smart phones) show promise as viable instructional tools for providing innovative, student-centered learning experiences.

Technology gives students the confidence and the tools to take an active part in their learning processes. They may no longer reap the benefits of being present in a traditional classroom. Being able to allow students to learn at their own pace and in their own time can reduce budgetary pressures on university resources while providing "just-in-time" experiential learning for students. Additional studies of computer-based instructional models merit serious consideration for continuous improvement initiatives to enrich students' learning experiences, maximize faculty productivity, and effectively manage scarce resources.

REFERENCES

Bennett, J., & Cooper, P. 2003. The computer literacy course: Putting it all together. **Information Systems Education Journal,** 2: 3-8.

Billings D. 1986. **Computer assisted instruction for health professionals**. Norwalk, CT: Appleton-Century-Crafts.

Bretz, R., & Johnson, L. 2000. An innovative pedagogy for teaching and evaluating computer literacy. **Information Technology and Management,** 1: 283-292.

Brown, P. 2000. Find out what a job candidate really knows. **Office Pro,** 60: 24-26.

Brown, S., Race, P., & Bull, J. 1999. **Computer assisted assessment in higher education**. London: Kogan Page.

Campbell, D., & Stanley, J. 1963. **Experimental and quasi-experimental designs for research.** Chicago: Rand McNally College Publishing.

Chang, B. 1986. Computer-aided instruction in nursing education. **Annual Review of Nursing Resources,** 4: 217-231.

Cooley, D., & Zhang, J. 1998. Computer-based teaching and assessment of computer and information literacy. **Journal of Technology and Teacher Education,** 6: 11-22.

Edmiston, E., & McClelland, M. 2001. A conversation about ensuring computer literacy of first-year students. **Journal of Computing in Small Colleges,** 16: 306-316.

Inoue, Y. 2000. The university student's preference for learning by computer-assisted instruction. **Journal of Educational Technology Systems,** 28: 277-285.

Kerlinger, F., & Lee, H. 2000. **Foundations of behavioral research.** Fort Worth, TX: Harcourt College Publishers.

Lancaster, D., & Willis, M. 1994. Computer-assisted instruction (CAI): A time-saving, individualized teaching methodology. **American Journal of Infection Control,** 22: 179-181.

Luna, C., & McKenzie, J. 1997. Testing multimedia in the community college classroom. **T.H.E. Journal,** 47: 78-81.

Mackin, P., Johnson, J., & Paranto, S. 2004. **Redesign of introduction to computers course.** Proceedings of ISECON 2004 Annual Conference on Information Systems Education. Newport, RI.

Marold, K., & Fustos, J. 2001. Hybrid delivery of computer literacy requirements for undergraduate business schools: A new model for a new millennium. **Informing Science,** June: 359-364.

Mawhinney, C. 1998. **The MSCD experience with putting business courses online.** Proceedings of the Twenty-Sixth Annual International Business Schools Computing Association, Denver, CO.

Pear, J., & Novak, M. 1996. Computer-aided personalized system of instruction: A program evaluation. **Teaching of Psychology,** 23: 119-123.

Porter, B. 2003. Raising the bar for student performance and assessment. **Learning and Leading with Technology,** 30: 14-17, 41.

Rasmussen, K., & Davidson, G. 1996. **Dimensions of learning styles and their influence on performance and attitudes.** Proceedings from the annual ED-MEDIA/ED-TELECOM conference, Article No. 385.

Robinson, L., & Thoms, K. 2001. A longitudinal study of college student computer knowledge. **Journal of Computer Information Systems,** 42: 9-12.

Ross, S., & Morrison, G. 2004. Experimental research methods. In D. Jonassen, (Ed.), **Handbook of research on educational communications and technology:** 1021-1043. Mahwah, NJ: Lawrence Erlbaum Associates.

Sax, L., Ceja, M., & Teranishi, E. 2001. Technological preparedness among entering freshmen: The role of race, class, and gender. **Journal of Educational Computing Research,** 24: 363-383.

Simis, P., & Hoong, I. 2001. **A comparison of using CBT and teaching assistants to teach Microsoft Office 2000.** Proceedings of ISECON 2001 18th Annual Conference on Information Systems Education. Cincinnati, OH.

Skinner, M. 1990. The effects of computer-based instruction on the achievement of college students as a function of achievement status and mode of presentation. **Computers in Human Behavior,** 6: 351-360.

Stephens, D. 2001. Use of computer assisted assessment: Benefits to students and staff. **Education for Information,** 19: 265-275.

Wallace, P., & Clariana, R. 2000. Achievement predictors for a computer-applications module delivered online. **Journal of Information Systems Education,** 11: 13-18.

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